CHAPTER 5: FISH

RAPID ASSESSMENT OF THE FISH BIODIVERSITY OF THE MBURO-NAKIVALI WETLAND SYSTEMS AND OPETA-BISINA WETLAND SYSTEMS, UGANDA

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5.1 Introduction

Lakes Bisina and Lake Opeta are *"finger lakes"*, extensions of Lake Kyoga, surrounded by swamp land during rainy seasons. These lakes are shallow, usually reaching a depth of a maximum of 6 meters and Lake Opeta usually forms a separate lake during dry seasons.

The lakes have three different environmental zones: the open clear water deeper than 3 m; the water less than 3 m, which is covered completely with water lilies and other submerged water plants like ceratophylum; and the swamps mainly papyrus, which fringe the shoreline. The lakes have a rich biodiversity that include flora and fauna such as *Cyperus Papyrus*, Hippo Grass (*Vossia Cuspidata*), Cattail (*Typha spp*.), Water lily (*Nymphea spp*.), and Water Lettuce (*Pistia stratiodes*). Large crocodile populations and other wild life.

There are 46 different fish species in the Lake Kyoga basin with some of them endemic. The Nile Perch (*Lates niloticus*) was introduced into the main Lake Kyoga, Nakuwa and Bisina in the late 1950s to increase the fish production. The Nile Perch profileration in lakes Kyoga and Nakuwa led to the almost complete elimination of many native fish species such as *Orechromis esculentus* and *variabilis*, *Mormyrus kanumme*, *Schilbe mystus* and several Haplochromines species.

Lakes Mburo, Kachera, Nakivali and Kijjanebalora are part of the complex system of lakes separated from Lake Victoria by extended swamps known as the Koki lakes, some of the satellite lakes in the Lake Victoria basin. The fisheries of these lakes are important as they contribute to government efforts of increasing food security, poverty reduction and conservation of natural resource base.

These lakes are important biodiversity areas because some of these lakes have been found to contain the native tilapiine *Oreochromis esculentus* (Ngege), absent or threatened with extinction in the main Lakes Victoria and Kyoga. It's also important to note that this species is only unique to the Victoria and Kyoga lake basins (Graham, 1929, Worthington, 1929). The values of some of these lake fisheries are however, threatened by human activities such as over exploitation, introduction of exotics especially water hyacinth that is already present in River Rwizi and habitat degradation among others.

The main human activities in the two wetland systems are fishing, cultivation, settlement and livestock keeping. There are no industrial enterprises in the area, due to lack of grid or any other power connectivity.

5.2 Why monitor fish diversity?

Fish diversity, species richness, species pollutant tolerance, disease prevalence and other metrics are used to evaluate the aquatic health of water bodies as with reference to generally agreed conditions. Fish as an indicator is widely regarded as one of the more reliable methods for assessing human-induced ecological impacts. Fish are always captured by a variety of methods but what is important is that collection should be representative of all the possible habitat types available in a water body.

5.3 Why use fish in monitoring?

a) The longer life span (3 to 4 years), exposes fish to years of impacts and provide a good assessment of long-term impacts
b) Fish represent a broad range of trophic levels.They may be strongly influenced by lower trophic levels (i.e. algae, macro-invertebrates etc.). Therefore fish assemblage provides an integrated view of the entire environmental system.
c) Fish are relatively easy to catch and identify; the environmental requirements and life history of fish are also well documented.
d) The general public is familiar with fishing for income, food and sport.
e) Water body aquatic life uses are depicted in terms of fish

5.4 Objectives

The overall objective of this assessment was to make an inventory of the fish status to guide the future biodiversity monitoring efforts aimed at suitable management. This was achieved specifically through:

a) Making an inventory of the fish species present in the two wetland systems and identify those that are endangered
b) Identifying how human activities threaten fish species diversity in the two wetlands systems

5.5 Materials and Methods

5.5.1 Study area

The assessment focused on two satellite lakes in each of the two wetland systems namely lakes Mburo and Kachera in the Mburo-Nakivali system, Lake Victoria basin; Opeta and Bisina in the Opeta-Bisina wetland system Lake Kyoga basin.

The Mburo-Nakivali weland system covers a surface area of about 570 Km^2. Lake Kachera is part of a complex of lakes (Mburo, Nakivali and Kiijanebalora) and extensive papyrus swamp (Burgis *et al.*, 1987) located at 00^0 35'S; 31^0 07' E, with a total surface area of 36.3 km^2, and a maximum depth of 4.1 m (Worthington, 1932). Lake Kachera has a maximum length of 20.0 km and width of 3.5 km (Atlas of Uganda, 1967; Welcomme, 1972;). The lake has one river out flow Kibali discharging through River Kagera into Lake Victoria. The size and shape of the lake varies from time to time due to floating islands. The shoreline vegetation is fringed with papyrus (*Cyperus papyrus)*, reeds (*Phragmites mauritianus)*, forest, and scattered banana plantations. Lake Kachera is borderd by Rakai district and Lake Mburo National Park and is exposed to very many anthropogenic factors. The communities around Lake Kachera have for long depended on fishing as a major economic activity. The non fishing communities around the lake are either traditional cattle keepers or cultivators, but most of the communities around the lake now practice mixed farming combining both livestock management and crop cultivation to varying degrees (Marquardt *et al*., 1994; Kamugisha *et al*., 1997; Namara and Infield, 1998; Emerton, 1999).

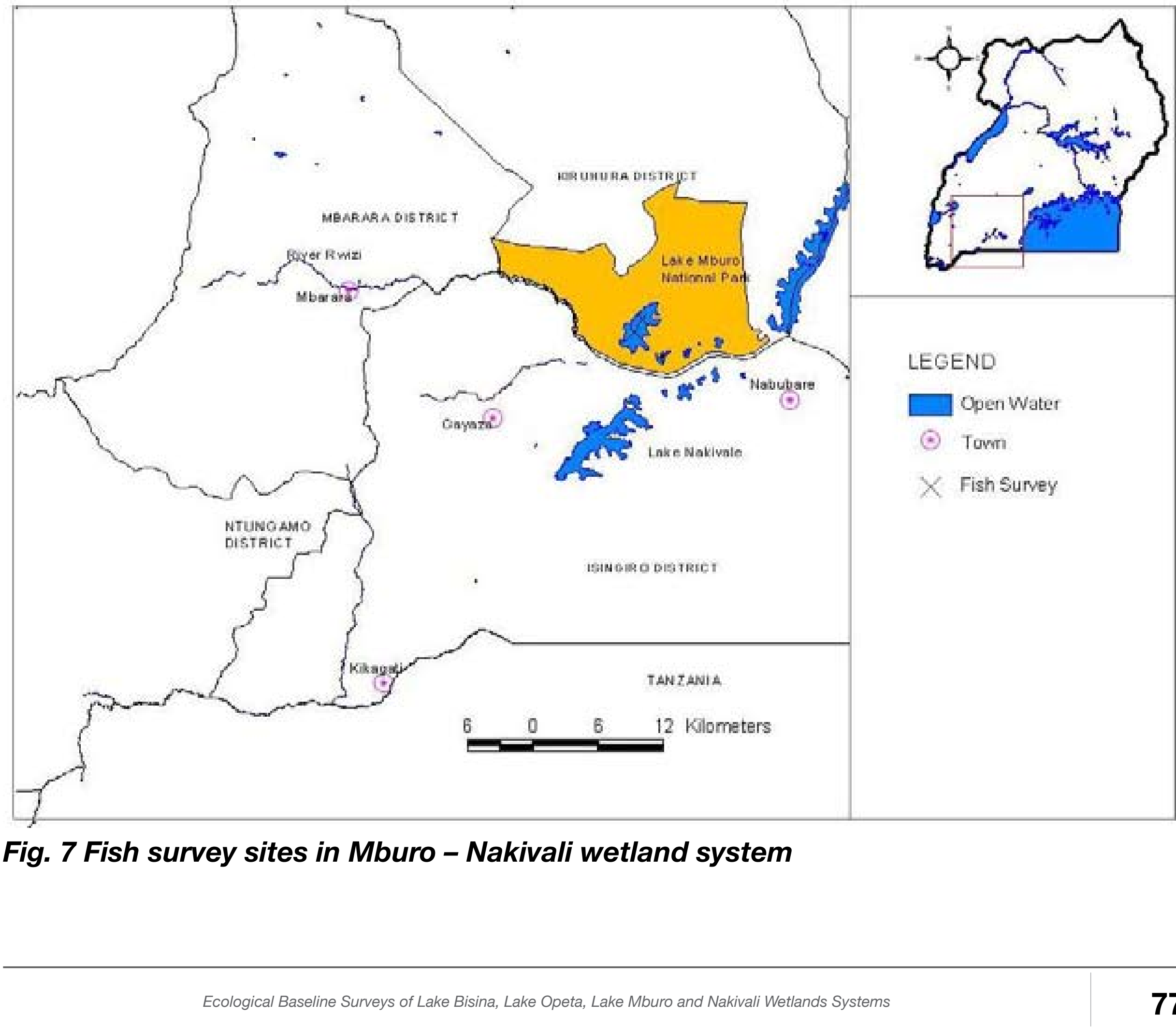

Fig. 7 Fish survey sites in Mburo – Nakivali wetland system

Lake Mburo is part of a complex of lakes (Mburo, Nakivali and Kiijanebalora) and extensive papyrus swamp (Burgis *et al.*, 1987) located at 00 40'S; 30^0 56' E in Kiruhura District in an area owned in precolonial days by the traditional King, the Omugabe of Nkore (Mugisha, 2003), it has a total surface area of 10.4 km^2, a maximum length of 6.0 km and width of 3 km (Atlas of Uganda, 1967). However, the size and shape vary from time to time due to floating islands. The inhabitants (Bahima) around the lake primarily use the riparian land for pastoralism. Until the intervention of colonial government, fishing was not an important economic activity in the lake (Mugisha, 2003). In 1983 Lake Mburo was gazetted as a national park (Burgis *et al*., 1987) and therefore fishing was restricted. Following the eviction of the last residents in 1997 there is no permanent human settlement in the 260 km^2 Lake Mburo National Park, apart from approximately 50 Uganda Wildlife Authority (UWA) staff and 100 or so workers and fisherfolk who temporarily reside at Lubale Landing site (Emerton, 1999). The economic benefits accruing from fisheries activities were valued at Ush 108.1 million in 1997, 7.6 million of which went to the national park as house maintenance fees, boat fees, and fuel wood fees for processors, and the rest to the Department of Fisheries Resources (Emerton, 1997). The National Park is characterised by high densities of animals most of which are native and the lake harbours large populations of hippopotamuses most of the daylight hours, spending the night out of the water.

Lake Bisina, is another large lake, located 272 km north east of the town of Jinja, in the shadow of Mt. Elgon at 01^0 38^{1}N 33^0 58^{1}E it has an elevation of 1048 m and has tiny crater lakes high in the mountains. Lake Bisina has a surface area of 308 km^2 (Atlas of Uganda, 1967) and a maximum depth of 3.5 m. Districts of Kumi (south) and Katakwi (North) border Lake Bisina. Lake Bisina like the main lakes Victoria and Kyoga was stocked with Nile perch and the tilapiines (*O. niloticus, O. leucostictus* and *T. zilli*) in the early 1970's. Lake Bisina is known by local inhabitants to have supported a Nile perch fishery however; this study did not record any Nile perch throughout the survey. Lake Bisina is one of the lakes internationally recognized as a biodiversity cradle, because they still contain remnants of native species flocks of cichlids that occurred in lakes Victoria and Kyoga before the Nile perch boom and demise of cichlid species (Mbabazi *et al.*, 2004; Schwartz *et al*., 2006).The lake is characterized by a variety of habitat types ranging from submerged aquatic macrophytes dominated by *Najas horrida* and *Ceratophyllum spp.* some floating water lilies (*Nymphaea* spp). Most of the lake's shoreline is fringed with hippo grass (*Vossia cuspidata*) and a very small portion of cattail (*Typha domingensis*). The human populations surrounding the lake are mainly pastoralist comunities keeping cattle and goats but they also do some crop cultivation.

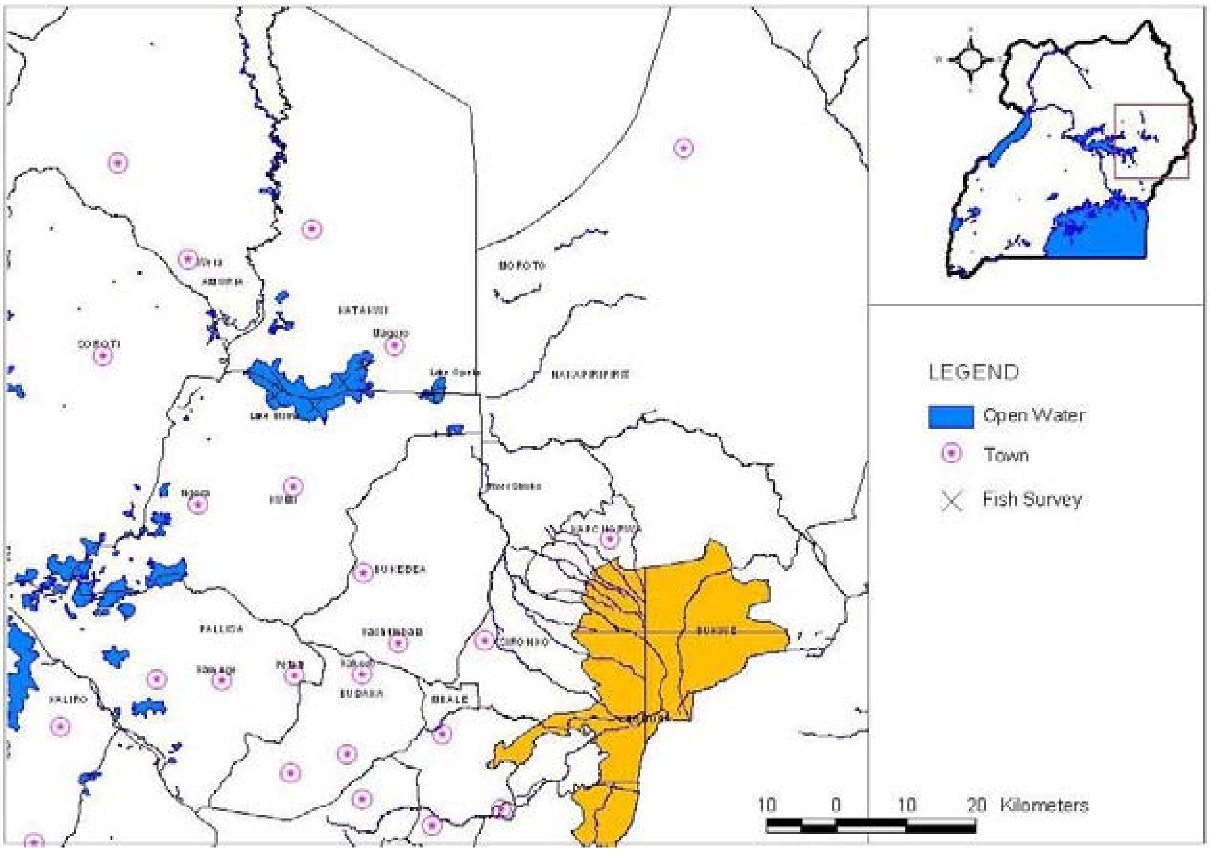

Fig. 8 Mammal survey sites in Opeta – Bisina wetland system

5.5.2 Data Capture and analysis

This assessment was based on data based on a single visit trip to one of the lakes Opeta and at a three months interval through a PhD study by Mbabazi between 2001 and 2003.

In all the above situations fish samples were obtained using multifilament experimental gill nets with stretch mesh sizes (25.4 to 203.2 mm) in increments of 12.7 mm intervals from 25.4 to 139.7 mm, and 25.4 mm intervals for nets ranging in mesh size 52.4 to 203.2 mm in a fleet of 90m long. The nets were set at dusk and retrieved the following morning. The fishes were sorted and identified to the lowest taxonomic level possible, number and weight of each taxon were recorded. The fishes that could not be identified especially haplochromine cichlids were preserved in 10% formaldehyde solution.

In the laboratory, the fishes were sorted into taxonomic groups (genera or species) based on morphometric and meritic procedures described by Greenwood (1981). Where a fish specimen was not exactly defined, it was assigned a “chieronym” (working name). (e.g. *Prognathochromis “shovel mouth”).*

Species composition and relative abundance of haplochromines were estimated from percentage contribution by number of each species.

5.5.3 Results

A total of 36 fish species belonging to 22 genera and 7 families. Of the fish species, 36 were from the Opeta-Bisina and 10 Mburo Nakivali wetland systems respectively (Table 1).

Table 1. The fish fauna of the Mburo-Nakivali and Opeta-Bisina wetland systems in Uganda

		Wetland System			
		Mburo-Nakivali		Opeta-Bisina	
Family	**Fish species**	**Kachera**	**Mburo**	**Opeta**	**Bisina**
Cichlidae	*Astatoreochromis sp.*	1	1	1	1
	Astatotilapia sp	1	1	4	3
	Haplochromis lividus			1	1
	Haragachromis spp.	1	1	1	3
	Lipochromis spp.			1	4
	Marcusenius spp.			2	
	Oreochromis spp.	3	3	3	3
	Pedicel				1
	Prognathochromis spp.			2	3
	Psammochromis spp.			1	1
	Pyxichromis spp.				1
	Tilapia sp.	1		1	1
	Xystichromis sp.			1	1
Mormyridae	*Gnathonemus spp.*			2	1
	Mormyrus sp			1	
	Petrocephalus spp.			1	1
Ciprynidae	*Bagrus spp.*			2	2
Characidae	*Brycinus sp.*			1	1
Claridae	*Clarias spp.*	2	2	2	2
Lepidosirenidae	*Protopterus sp.*	1	1		1
Schibeidae	*Schilbe sp.*				1
Machokidae	*Synodontis spp.*			1	2
= 8	= 22	= 10	= 9	= 28	= 34

The species richness was higher in the Opeta-Bisina wetland system (28 and 34) compared to the Mburo-Nakivali system (9 and 10). Subsequently, the Opeta-Bisina system had species richness of haplochromines (20) than the Mburo-Nakivali system (only 3). In both systems the native tilapiine *Oreochromis esculentus* co-existed with the introduced *Oreochromis niloticus* while the former was eliminated in the main lakes where Nile perch was introduced.

Table 2. The Mburo-Nakivali and Opeta – Bisina wetland systems and their species of biodiversity importance.

Wetland System	Lake	Species of Biodiversity importance
Mburo-Nakivali	Nakivali	*O. esculentus*
	Mburo	*O. esculentus*
	Kachera	*O. esculentus*
	Kijanebalola	*O. esculentus*
Opeta-Bisina	Bisina	Haplochromines, *O. variabilis*
	Opeta	*O. variabilis*, Haplochromines

5.6 Threats to Fish Biodiversity

The threats to fish species can be grouped into five interacting categories. Over-exploitation; introduction or invasion of exotic species; pollution and eutrophication; flow modification; destruction or degradation of habitat; and climate change.

Over exploitation is the result of harvesting or killing animals or plants, for food, materials or medicine, over and above the reproductive capacity of the population to replace itself. Overfishing has been the dominant threat to fish biodiversity and has devastated many commercial fish stocks. Overfishing reduces the size and genetic diversity of affected fish population. This decline has been found to reduce reproductive success and increase susceptibility of stocks to disease and environmental stresses. The problem of by catch of non-target species and under-sized juveniles of target species caught sometimes exceeds the saleable sizes. Overfishing can also lead to complete collapse of the target species and an ecosystem as a whole, termed as a trophic cascade. Collection of ornamental fish had also threatened fish diversity in Lake Bisina and Nawampasa in the late 1990s. Over harvesting of papyrus for art crafts, building and construction is another threat because it exposes the lakes to possibility of invasion of species e.g. Nile perch

Pollution problems arising from land based activities contaminate the lake with heavy metals and pesticide residues. Pollution also comes from, agriculture as well as households, either by direct disposal of harmful substances into the water bodies or indirect discharges that reach the lakes via rivers. Persistent organic pollutants consumed by organisms at the bottom of the food chain get concentrated as predators eat contaminated prey. The threat of excessive nutrient enrichment is a reality. Despite the growing pollution threat there are currently no targeted efforts to reduce water pollution.

Habitat degradation is brought about by an array of interacting factors. It may involve direct effects on the fish habitat such as cultivation up to the Lake margin or indirect impacts which are already evident, e.g. the high human population density in the basin leads to accelerated conversion of forests to agricultural land. The consequences of these include increased surface runoff and river sediment loads that can lead to habitat alterations such as shoreline erosion, smothering of littoral habitats, clogging of river bottoms or wetland aggradations besides destruction of refugia.

Reduction in water levels in water bodies is another threat to fish diversity in the form of habitat reduction. For example historical natural water level fluctuations, due to changes of climate and river discharge may lead to a reduction of levels. The level on the coastline reduces thus reducing fish habitats in the littoral areas and posing potential negative impact on fish diversity.

Flow modifications are very common in running waters and this is not an exception to the lakes in the wetland systems. Regulation of rivers that flow into the lakes could be one of the most significant anthropogenic impacts on the biodiversity of the lake e.g. River Ruizi that enters Lake Mburo through Kachera, Kijanebalola into Lake Victoria. Changes in the hydrological regimes, reducing spring run-off, can lead to increased shoaling of river delta and reduction in the area of delta vegetation (reeds, cat-tail, and bushes). This loss of vegetation can result in a loss of aquatic fauna especially the migratory and semi-migratory fish species that are deprived of their natural spawning grounds. As spring flows are reduced, fish migration upriver for spawning is impeded and essential nursery areas are limited.

Wide spread invasion and deliberate introduction of non-indigenous species adds to the physical and chemical impacts of humans to fish species diversity, in part because exotics usually successively invade native species already modified or degraded by humans e.g. the introduction of Nile perch and four tilapiine species in the basin provides a classic example. Escape of farmed fish into the wild is also associated with the floods that are common in these wetland systems.

Climate change has started manifesting itself recently and its impacts can easily be depicted e.g. the current water fluctuation levels in water bodies. Climate change is associated with the continuous global increase in temperature and green house gas emissions. The global extent of climate change will mean that no ecosystem on earth will be immune from rising air or sea temperatures or changing weather patterns. The impact of climate changes on fish diversity in the basin is not yet well understood, but a general increase in ultraviolet radiation due to ozone depletion harms microscopic, photosynthetic algae and zooplankton at the base of the aquatic food web, potentially affecting the food supply of the entire water body community. Climate change may not only result in water level rise and severe storm damage but also temperature, salinity and other parameters causing a wide range of effects from species mortality, modifying species composition and migratory patterns to shifts in the entire aquatic system. However, the impact of climate change on biodiversity may be gradual compared to other threats.

5.7 Discussion

The first fishery survey of lakes Mburo and Kachira by Worthington (1929) up to early 1950s the most important commercial fish species in the lakes were *Clarias spp*, the lung fish *Protopterus eathiopicus* and haplochromines (Worthington, 1932). In lakes Opeta and Bisina like in the other Kyoga lakes the most important commercial species in order of importance were native tilapiines (*O. esculentus* and *variabilis*), the lung fish and catfishes *Bagrus docmak*, *C. gariepinus*, *Schilbe intermedius*, *Barbus spp*, Haplochromines and momyrids. The present surveys indicate that the fish communities of most of the assessed lakes in the wetland systems are composed of native species however in the Mburo-Nakivali systems new species were recorded namely *O. esculentus* and *O. niloticus* and these species were introduced in these lakes and dams in the early 1950s when the general introductions took place. Among the tilapiines cichlids, significant populations of the two native tilapiines remain in these lakes although they have been displaced from the main lakes Victoria, Kyoga, Nabugabo and Nakuwa where Nile perch has established (Ogutu-Ohwayo, 1990; Mbabazi et al., 2004; Chapman *et al.*, 2008). The native tilapiines, which have disappeared from the main lakes, survive as both native and introduced populations in satellite lakes within the Victoria and Kyoga lake basins. The lakes in the two wetland systems still house remnants of the native species especially haplochromines which were thought to be eliminated in the main lakes Victoria and Kyoga. Because of their structural heterogeneity of macrophyte cover separating these lakes from the main lakes that make it difficult for the predatory Nile perch to access the lakes (Chapman *et al.*, 1999; Mbabazi *et al.*, 2004).

5.8 Conclusions

a) The native tilapiines, which have disappeared from the main lakes, survive as both native and introduced populations in satellite lakes in wetland systems within the Victoria and Kyoga lake basins.
b) The native haplochromine that existed in Lake Victoria and Kyoga prior to the Nile perch boom are still present in the Opeta-Bisina wetland system.
c) The two wetland systems therefore contribute to conservation of fish species diversity threatened by introduction of exotics and other anthropogenic factors in the Victoria and Kyoga basin lakes.

5.9 Recommendations

a) It is therefore recommended that some of the Lakes in the wetland systems around Lakes Victoria and Kyoga be designated as conservation areas of haplochromines and other species threatened by introductions of exotics in the main Lakes.
b) There is need to prevent clearing of vetetation that separate these lakes from the main Lakes to avoid colonization by the Nile perch
c) Discourage harvesting of ornamental fish from these Lakes and instead introduce them in aquaculture.
d) There is need to initiate the development of management plans that will guide the implimentation of all conservation interventions.

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